

**APPLICATION FOR UNITED STATES LETTERS PATENT**

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**TITLE:** Intermittent Module

## **INTERMITTENT MODULE**

### **Field of Invention**

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This invention relates to an intermittent pressure module for controlling the position of a valve between two positions, and particularly relates to a vacuum regulator having a removably securable, intermittent vacuum module for producing intermittent regulated vacuum flow. The invention also relates to a method of producing an intermittent vacuum by moving a valve to a first position to couple a supply of vacuum to a diaphragm chamber and a second position for evacuating the vacuum in the diaphragm chamber.

### **Background of the Invention**

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A variety of devices have heretofore been produced and utilised in order to deliver an intermittent pressure. Such pressure can be positive in the sense of being greater than ambient pressure or negative when dealing with a vacuum.

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In one such application, the aspiration of fluids from a patient is accomplished by providing a vacuum source to the internal body area of the patient requiring aspiration. Typically, unregulated hospital vacuum line pressure is approximately between 19 to 25-inches of mercury Hg.

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The use of vacuum regulators as medical devices is well known to achieve such aspiration of fluids.

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Generally speaking, such vacuum regulators are attached to a vacuum outlet in the wall of the patient's hospital room and known vacuum regulators are utilised in order to select the desired level of vacuum.

Furthermore, some of the vacuum regulators also include an intermittent vacuum regulator with a timing module in order to apply intermittent vacuum to a patient followed by exposure to an ambient pressure. For example, the US Patent No. 5,599,308 teaches an intermittent vacuum regulator having a timing  
5 module in combination with a valve for controlling the position of the valve between two or more states.

Moreover, U.S. patent no. 6,228,056 B1 illustrates an intermittent regulator in which the regulator alternates between supplying partial vacuum to a patient  
10 for withdrawing fluids from the body of a patient, and supplying atmosphere to a patient, at a selected intermittent rate, that is adjustable upon adjusting a timing mechanism.

Moreover, U.S. Patent Nos. 4,782,849 and 4,830,047 each illustrate a  
15 controlled unit for an intermittent suction system.

Furthermore, U.S. Patent No. 5,265,638 shows an intermittent suction device for removing fluids from a patient where the duty cycle between the off and on cycle is controlled by a magnetically susceptible diaphragm that switches  
20 back and forth between a first and second position.

Furthermore, U.S. Patent No. 5,265,639 shows a magneto-pneumatic timing device that provides a pressure signal alternating between a high and low pressure output signal.

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It is an object of this invention to provide an improved intermittent pressure module. It is further object of this invention to provide a vacuum regulator having an intermittent vacuum module, which is removable and securable thereto. It is a further object of this invention to provide an improved method for producing an  
30 intermittent pressure. It is a further object of this invention to provide a regulator that may be convertible from a regulated substantially constant pressure flow to an intermittent pressure flow.

It is an aspect of this invention to provide an intermittent pressure module for controlling the position of a valve between two positions comprising a diaphragm; a plurality of ports associated with said diaphragm for exposing the diaphragm to a selected supply pressure in a first position and another pressure in a second position; and swing arm structure associated with the diaphragm and the valve for intermittently displacing the valve when the diaphragm is exposed to the selected supply pressure in the first position and said other pressure in the said second position.

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It is another aspect of this invention to provide a vacuum regulator having: an intermittent channel for vacuum flow; a regulated channel for regulating a level of vacuum; an intermittent vacuum module removably securable to the vacuum regulator, the intermittent vacuum module presenting an intermittent port for communicating with the intermittent vacuum channel, a regulated port for communicating with said regulator channel, a diaphragm assembly displaceable within a diaphragm chamber having a diaphragm port, and a valve for intermittently connecting the intermittent port with the diaphragm port so as to expose the diaphragm assembly to a vacuum in a first position, and for connecting the intermittent port to the regulator port to relieve the vacuum from said diaphragm chamber (i.e. inflate the diaphragm chamber) to ambient pressure in a second position, and swing arm associated with a diaphragm assembly and the valve for intermittently displacing the valve when said diaphragm is exposed to the vacuum in the first position and ambient pressure in the second position.

It is another aspect of this invention to provide a method of producing an intermittent vacuum by moving a valve to a first position to couple a supply of vacuum to a diaphragm chamber having a diaphragm move in response to the vacuum for moving a spring loaded swing arm so as to move the valve to a second position to couple the supply of vacuum to a regulated port and relieve the vacuum from the diaphragm chamber (i.e. inflate the diaphragm chamber)

and move the diaphragm in response to said relief for moving said spring loaded swing arm so as to move the valve to the first position, repeatedly.

These and other objects and features of the invention shall now be  
5 described in relation to the following drawings:

**Brief Description of Drawings**

Fig. 1 is a top plan view of the back face of Fig. 1.

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Fig. 2 is the front view of the vacuum regulator .

Fig. 3 is a partial exploded view of the vacuum regulator.

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Fig. 4 is the rear face of the selector dial.

Fig. 5 is the front face of the selector dial.

Fig. 6 is a top plan view of a full-mode selector gasket.

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Fig. 7 is a top plan view of an intermittent mode selector gasket.

Fig. 8 is a perspective of an assembled intermittent module.

Fig. 9 is a top cover plate shown in Fig. 8.

Fig. 10 is the upper face of intermediate intermittent vacuum section  
25 shown in Fig. 8 (i.e. the face that contacts the top cover plate).

Fig. 11 is the upper face of intermittent base portion that contacts the face  
shown in Fig 12.

Fig. **12** is a view of the lower face of intermittent intermediate portion of the intermittent module showing the diaphragm chamber.

Fig. **13** is a perspective view of the intermittent port selector valve.

Fig. **14** is a perspective view of a needle valve.

5 Fig. **15** is a perspective view of a needle body.

Fig. **16** illustrates an exhaust needle.

Fig. **17** illustrates an exhaust needle body.

Fig. **18** illustrates a rolling diaphragm.

Fig. **19** is a perspective view of the upper support plate.

10 Fig. **20** is a perspective view of the lower support plate.

Fig. **21** is a perspective view of the timing module.

Fig. **22** is a partial side perspective view of the spring-loaded swing arm.

Fig **23** illustrates a perspective bottom view of the module base

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Figures **24a** and **24b** illustrates another embodiment of the mechanical switching mechanism

Figure **25** illustrates the ball and socket embodiment of the invention.

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Fig. **26** illustrates another embodiment of the valve

Fig. **27** illustrates a steel plate.

Figs. 28 and 29 illustrate another embodiment of the intermediate section

Fig. 30 illustrates another embodiment of the timing mechanism.

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### **Description of the Preferred Embodiment**

In the description that follows, like parts are marked throughout the specification and the drawings with the same respective numbers. The drawings  
10 are not necessarily to scale and in some instances proportions have been exaggerated in order to more clearly depict certain features of the invention.

Furthermore the invention to be described herein is applicable to regulate and deliver an intermittent pressure which may be positive or negative relative  
15 ambient atmospheric pressure. Therefore although one preferred embodiment is described in relation to a vacuum (i. e. negative pressure) the invention embraces positive pressure intermittent flow as well. Although the invention is described in relation to air it is applicable to other gases and fluids.

20 Fig. 1 represents the back inner surface of the front body 18 while Fig. 2 represents the front outer surface of the front body 18. The invention described herein utilizes four channels namely regulator channel 5, vacuum channel 6, output channel 7, and intermittent channel 10 as shown in Fig. 1. Furthermore the front surface of front body presents four ports, namely a pressure relief port 9,  
25 bleed port 62, regulator channel port 12 and intermittent channel port 14.

Typically prior art regulators utilise a three channel two port design. The three channels that prior art devices exhibit are the vacuum channel 6, regulator channel 5 and output channel 7. The two ports that prior art devices exhibit are  
30 the pressure relief port 9 and bleed port 62. The pressure relief port 9 is typically covered by a duckbill 26 which embraces the circular flange 63 in a manner well known to persons skilled in the art. Pressure relief port 9 communicates with

vacuum channel **6**, and if a selected positive pressure is experienced in vacuum channel **6** the duckbill **26** flexes from relief port **9** to permit pressure to vent to atmosphere rather than into the patient. Bleed port **62** communicates with output channel **7** and is utilised to properly regulate the unit in a manner well known to those persons skilled in the art and may comprise an orifice for example 13 thousandths of an inch in diameter that sucks in air or depressurizes when the system is off.

In the drawings the intermittent channel port **14** communicates with intermittent channel **10**, pressure relief port **9** communicates with vacuum channel **6**, bleed port **62** communicates with output channel **7** and intermittent channel port **14** communicates with intermittent channel **10**, and regulator channel port **12** communicates with regulator channel **5**.

Fig. 3 illustrates generally the various components of the vacuum regulator **16** as illustrated in Fig. 1 and 2. Generally speaking the vacuum regulator **16** includes a front body **18**. The backside of the front body **18** contains the channels or passageways **5**, **6**, **7** and **10** previously described. The front body **18** registers with a back body **20** and is fastened thereto by means of screws or the like in a conventional manner. A gasket **22** having the general profile of the channels and holes is provided between the front face **18** and the back body **20**. The rear surface of the back body **20** includes a vacuum inlet **24** which is secured to a common vacuum source in a hospital or the like.

Accordingly, vacuum pressure is introduced through inlet **24** which communicates with the vacuum channel **6** and communicates with vacuum selector port **26**; and pressure relief port **9** communicates with the vacuum channel **6** but is typically covered by a duck bill port cover **26** as shown in Fig. 2. More particularly, the duck bill port cover **26** is utilized as a safety feature in the event that a positive pressure is accidentally introduced into the output channel thereby opening the duck bill port cover **26** to permit venting of the pressure to atmosphere, and preventing positive pressure from being introduced to patient.



A selector dial **28** is utilised to select the vacuum regulator **16** in the "off" mode, "full" vacuum flow mode, or "regulated" mode as shown in Fig. 3 4 and 5. More specifically the selector dial **28** has an inner operating face **30** with a pair of kidney-shaped recesses **32** and **34**, which selectively allow the communication of vacuum between the vacuum selector port **26** and the regulator channel **5**. More specifically, a gasket shown in Fig. 6 is sandwiched between face **30** of selector dial **28** and selector face **36** as shown in Fig. 2. The selector face **36** includes the vacuum selector port **26** which communicates with hole **27** of gasket **38**, a full output selector port **40** which communicates with hole **41** of gasket **38**, intermittent selector port **42** which communicates with intermittent hole **43** of gasket **38**, and regulator selector port **44** which communicates with hole **45** of gasket **38**.

Accordingly, when the selector dial **28** is manipulated so that recess **34** couples the vacuum selector port **26** with the regulated port **44** input vacuum from the vacuum channel **6** is directed to the regulated channel **5** which communicates with the regulator well **46** in a manner well known to those skilled in the art. The regulator well **46** receives a regulator assembly **48** and is sealed thereto by O rings **50**. The regulator **48** permits selection of a desired level of pressure namely vacuum pressure to be delivered through the patient output port **52** in a manner well known to those persons skilled in the art.

Furthermore if the selector dial **28** is manipulated so that recess **32** couples vacuum selector port **26** with hole outlet selector port **40** full vacuum pressure communicates between the vacuum channel **6** and output channel **7** delivering a full vacuum to the patient outlet **52**. The selector plate may also be manipulated in an off position.

The output channel **7** includes an aperture **54** which communicates with a projecting hollow flange **56** for receiving a gauge assembly **58** for displaying the level of vacuum. The gauge assembly **58** can comprise of a rotary dial or digital

gauge. O rings **60** provide the necessary sealing of the gauge assembly **58** within the hollow flange.

A bleed outlet **62** is included in the output channel **7** and is sized to  
5 provide optimal vacuum operation in a manner well known to those persons skilled in the art.

The vacuum regulator **16** is dimensioned so as to permit retro fitting into a standard three channel vacuum regulator with the four channel vacuum  
10 regulator having intermittent capability to be described herein. In other words a standard prior art three channel two port regulator may be removed from its housing (not shown) and the four channel four port regulator **16** described herein substituted in its place.

15 When utilising the intermittent mode, of the vacuum regulator **16** the full mode selector gasket **38** described in Fig. 6 is replaced by the intermittent mode gasket **64** illustrated in Fig. 7. The intermittent mode selector gasket **64** shown in Fig. 7 is similar to the gasket **38** shown at Fig. 6 except that the selector output port **40** of gasket **38** has been blocked so as to disable the full vacuum output  
20 channel. Moreover, the selector dial as shown in Fig. 4 is utilised whereby the kidney shaped recess **32** is longer than the kidney shaped recess **34** so as to permit the vacuum source from the vacuum selector port **26** to communicate with the intermittent selector port **42**.

25 The face **30** of selector dial **28** gasket and selector face **36** are dimensioned so as to provide a sealed fit there between with substantially no pressure leakage.

The selector dial **28** is received by post **66** and is secured thereto by  
30 fastening means such as a screw **67** or the like. The selector face **36** includes a small ball **68** that is positioned on the free end of a spring **70** and adapted to

engage with detents **72** to secure the selector dial **28** in the three positions namely intermittent, off, and regulated flow.

Each of the gaskets **38** and **64** include a hole **76** which is adapted to  
5 receive the ball **68**.

When utilising the vacuum regulator **16** in an intermittent mode module **80** is added to the regulator **16**. The intermittent module **80** comprises a cover plate **82** intermediate section **84** and base section **86**.

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In order to upgrade the vacuum regulator to permit intermittent pressure flow, the intermittent module **80** must be attached and the vacuum regulator selector gasket **38** replaced with the intermittent mode selector gasket **64** so as to convert the "full" mode position of a selector to a "intermittent" mode. Moreover  
15 the indicia **29** on the face plate of the selector **28** will be changed to indicate "Off" " Intermittent " and " Regulated " pressure modes. The gasket **68** accomplishes this by blocking the output selector port **40** and allowing access to the intermittent channel **10**.

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The intermittent module **80** slides on and seals against the intermittent channel port **14** and regulator channel port **12**. The intermittent module **80** includes module intermittent port **89** and module regulator port **103** located on the base **86** as best seen in figure 23 which communicate and seal with the intermittent port **14** and regulator port **12** referred to above. Furthermore recess  
25 **77** accommodates the insertion of pressure relief port **9** while recess **79** accommodates the insertion of flange **63**. "U-shaped cut out **81** registers with and is located by locating post **75** so as to securely receive the intermittent module **80**.

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The intermittent port **14** permits access to the vacuum supplied to the vacuum regulator **16** only when the regulator is in the intermittent mode as previously described. The regulator port **12** allows access to the regulator **48** as

previously described. The module intermittent port **89** communicates with passage **88** extending through base **86** and passage **92** extending through intermediate portion **84** while module regulator port **103** communicates with passage **107** extending through base **86** and intermediate portion **84**.

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When the vacuum regulator **16** is in the "intermittent" mode the intermittent module **80** is continuously supplied with a vacuum from vacuum channel **6** through vacuum selector port **26** coupled by recess **32** to intermittent selector port **42** through intermittent channel **10** to the intermittent port **14** which communicates with the module intermittent port **89** and passage **88**. Passage **88** in turn communicates with passageway **92** through intermittent portion **84**. The other end of passage **92** communicates with intermittent valve port **101** of the intermittent module **80**. Moreover passage **107** communicates with module regulator port **103**.

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The intermittent module **80** controls the intermittent delivery of vacuum pressure to a patient in a selected ratio such as for example 2:1 timing ratio. In other words the 2:1 ratio represents the vacuum being on twice as long as the vacuum being off. Other ratios can however be selected.

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The intermittent module **80** comprises an intermittent port selector valve **104**, deflate timing needle valve **106**, diaphragm assembly **108** and spring loaded swing arm **110**.

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The intermittent port selector valve shown in Fig. 13 is utilised to connect two port holes together. In particular, the intermittent port selector valve **104** is retained in port select valve recess **112** disposed in intermediate section **84** shown in figure 12 and 21. The port selector valve recess **112** includes the intermittent module port **101**, intermittent regulator port **102**, diaphragm port **103** and exhaust port **148**. Depending on the position of the port selector valve **104** it will connect the intermittent module port **101** to the regulator module port **102** or the intermittent port **101** to the diaphragm port **103**.

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The port selector valve **104** is generally triangular in shape with oval cups **111** and **113** at its larger end used to connect two ports. Oval cup **113** is larger than **111**. Furthermore the port selector valve **104** includes aperture **114** which is adapted to receive a pin **116** for pivotal movement about pin receiving hole **118** as shown at Fig. 12 and 21. An air -tight seal is made between the valve **104** and the surface **120** surrounding the ports **101**, **102** , **103** and **148** by utilising highly planar surfaces.

10 When the intermittent port selector valve **104** is moved so that cup **113** couples or connects the intermittent module port **101** to the diaphragm port **103** the module regulator port **102** is left open to atmosphere and there is no vacuum delivered to the patient. Furthermore exhaust **148** is disposed under cup **112**. In this position, the air in the diaphragm chamber **122** is evacuated at a rate  
15 depending on the deflate timing needle valve **106** since the diaphragm port **103** is connected to the diaphragm chamber **122** by means of needle passage **200** and port **201**.

The deflate timing needle valve **106** is disposed in passage **200** . Deflate  
20 timing needle valve **106** comprises of a needle valve portion **128** having angled portion **127** which is received in needle body **124**, having an angled seat portion **125** . Both deflate timing needle valve **106** and needle body **124** are received by receiving hole **126** shown in Fig. 10. The deflate timing needle valve **124** includes the needle portion **128** which is received within the hole **130** of needle  
25 body **124**. The other end of the deflate timing needle valve **106** includes a threaded end **135** which is threadedly received within a threaded hole **134** presented by the intermittent cover plate **82**. The deflate timing needle valve **106** includes a tool-receiving head **140** which permits rotation of the needle. The needle body includes a hole **123** there through which intersects valve seat **125**  
30 twice ,and which is adapted to be aligned with needle passage **200** which has one end **201** communicating with diaphragm chamber **122** and another end which communicates with diaphragm port **103**.

Depending on the tightening of the needle the size of the orifice between the diaphragm chamber **122** and the exhaust passage **200** ( by means of hole **123** ) is either increased or decreased to increase or decrease the time duration  
5 of the evacuation or introduction of air out of or into the diaphragm chamber . As the needle valve is tightened so that the space between the angled surface **127** and seat **125** is made smaller the time duration increases , while the time duration is lessened by increasing the space. During the time the vacuum is introduced or diverted into the chamber the patient gets no vacuum. Thus the  
10 deflate timing needle valve **106** controls the time that the patient does not get vacuum.

The valve recess **112** also includes an exhaust port **148** which communicates with an inflate timing needle valve **150**. The inflate timing needle  
15 valve registers with exhaust body **152** retained by exhaust body hole **154** as shown in Fig. 8, 9 and 10. The inflate timing needle valve **150** includes an angled portion **157** ,a threaded end **156** which is slotted at **162** so as to permit threaded engagement with a threaded hole **160** located on a intermittent cover shown at Fig. 8 and 9. The inflate timing needle valve **150** has a hole **155** disposed axially  
20 through the inflate timing needle valve **150** from the slotted end **162** to the other end as shown. The exhaust body **152** includes a valve seat **159** and a hole **153** which intersects the valve seat **159** once ( ie half way ) .The hole **155** exhausts to atmosphere by means of passage **203** . Passage **203** communicates with the exhaust port **148** at one end and with hole **123** at the other end thereof. The  
25 slotted end **162** is adapted to be manipulated so as to select the time that the patient has vacuum. The smaller the effective space between the valve **157** in fig 16 and the valve seat **159** in fig 17 the more vacuum time the patient will receive.

The diaphragm assembly comprises a rolling diaphragm **190**, upper  
30 support plate **192**, lower support plate **194** and spring **196**. Diaphragm **190** is pressed between the upper and lower support plates **192** and **194** as shown.

The diaphragm **190** seals the diaphragm chamber **122** which in turn is connected to the diaphragm port **103**.

5 The spring **196** is disposed so as to contact the lower surface of the diaphragm chamber **122** and the lower support plate **194** as shown. The spring **196** exerts a force to push the diaphragm **190** away from the lower surface of the diaphragm chamber **122**. The upper support plate **192** has a raised section **200** with a hole **202** for pivotal movement thereabout. The upper portion **200** is pivotally connected to a spring-loaded swing arm **110**.

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When the diaphragm port **103** is connected to the vacuum supply through the intermittent port **101** by means of the port select valve **104** the vacuum will evacuate the air within the diaphragm chamber **122** causing a strong compression force against spring **196** (during this time as mentioned above the intermittent regulator port is left open to atmosphere and no vacuum delivered to the patient). In the orientation shown in Fig. 22, the strong downward force from the vacuum will cause a strong downward force from the diaphragm **190** against the spring **196** resulting in a negative or downward displacement of the upper support plate **192**.

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When the port selector valve **104** is moved so cup **113** connects the module regulator port **102** and intermittent module port **101** vacuum is supplied to the patient . At the same time the diaphragm **103** is coupled to exhaust port **148** by means of cup **111** and thus the diaphragm is open to atmosphere ( through both deflate timing needle valve **106** and inflate timing needle valve **150** ) which will return the diaphragm chamber **122** to atmosphere pressure. During this time vacuum is supplied to the patient through the intermittent regulator port, and regulator channel as described above. The return of the positive pressure will lessen the downward force on the diaphragm **190** onto the spring **196** allowing the spring **196** to decompress back to its original state resulting in a positive displacement of the upper support plate **192**.

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The spring loaded swing arm **110** acts as a timing or switching module for the intermittent port select valve **104** between two possible positions. The maximum and minimal vertical positions of the upper support plate **192** signals the spring-loaded swing arm **110** to switch between the two positions of the valve. The spring-loaded swing arm **110** comprises a cantilever arm **220**, a swing arm **222**, and a spring **224**.

One end **226** of the cantilever arm **220** is connected to the hole **202** so as to provide a pivot point **228** to the upper end of the support plate **200**. The other end **223** of the cantilever arm **220** is connected to a pivot point **230**. In particular, end **223** of the cantilever arm **220** includes a hole and the swing arm **222** also includes a hole adapted to receive a pin **240** which is fixedly secured to a hole **240** (as shown in Fig. 8) namely the intermittent module casing.

One end of the swing arm **222** has a protruding stem **246** that runs through an appropriate hole **248** in the port selector valve **104**. The other end **250** of the swing arm **122** is attached to a compressed spring **224** of which the other end of the compressed spring **224** is secured to the cantilever arm **220** close to the pivot point **228** with the upper support plate **192**.

Generally speaking, the spring **224** is stable in three positions only, namely,

1. When the cantilever arm **220** and swing arm **222** are in a generally horizontal alignment with each other whereby generally speaking the force of the compressed spring travels through both pivot points **228** and **230**; and
2. When the cantilever arm **220** is pulled downwardly by the upper support plate **192** (when referring to Fig. 22). In other words when the diaphragm chamber is exposed to a vacuum the upper support plate will travel downwardly and the vertical component of the spring **224** will cause the swing arm **222** to move quickly clockwise



resulting in the quick switching of the intermittent port select valve **104** to connect intermittent ports **101** and **102**. Vacuum will be delivered to the patient when valve **104** connects intermittent ports **101** and **102**. At the same time the ports **103** and **148** are connected to inflate the diaphragm chamber **122**.

3. When the cantilever arm **200** is pushed up by the upper support plate **192**. This occurs when atmospheric pressure is exposed to the diaphragm chamber **122** so that the upper support plate **192** will travel upwards and the vertical component of the spring **222** will cause the swing arm to move quickly counter clockwise resulting in a quick switching of the intermittent port selector valve **104** to connect ports **101** and **103**. Vacuum will be delivered to the diaphragm chamber and not the patient when valve **104** connects intermittent ports **101** and **103**.

The intermittent pressure module **80** described above controls the position of the valve **104** between two positions and comprises the diaphragm assembly **108**, a plurality of ports **101**, **102**, and **148** associated with the diaphragm assembly **108** for exposing the diaphragm assembly **108** between a selected pressure in the first position and an ambient pressure in the second position, and comprises a spring loaded swing arm associated with the diaphragm assembly **108** and the valve **104** for intermittently displacing the valve **104** when the diaphragm assembly **108** is exposed to the selected pressure in the first position and the ambient pressure in the second position.

The valve **104** couples the vacuum and the intermittent module port **101** with the diaphragm port **103** for communicating vacuum pressure with the diaphragm chamber **122** so as to draw the diaphragm assembly **108** to the first position. Moreover, the valve **104** couples the vacuum and the intermittent module port **101** with the module regulator port **102** to deliver vacuum to the patient and port **148** and port **103** is connected to inflate or relieve the vacuum

from the diaphragm chamber **122** and move the diaphragm assembly **108** to a second position.

Fig 24a and 24b illustrate another embodiment of the invention where the  
5 swing arm **222** has a removeable stem **246** adapted to be received by hole **247** .  
A socket **251** is disposed at another end **250** of swing arm **222**. The socket **251**  
as shown is spherical and adapted to receive ball joint **253** shown in figure **24b**.  
The ball joint **253** is located at on end of a ball shaft **257** . The other end **259** of  
the ball shaft **257** is received by hole **261** presented by cantilever arm **220** . The  
10 hole **261** slidngly receives ball shaft **257** during the motions previously described.  
The spring **224** is received by the ball shaft **257** for improved location and  
operation as shown .The ball joint will rotate or swivel within socket **251** during  
the motions described.

15 Figures 26 and 27 illustrate another embodiment of the invention. Valve  
**104** includes two kidney shaped couplers **300** and **301** as well as a hole **302** for  
reception of stem **246** . A sealing plate **304** which can be comprised of steel or  
the like is attached to valve recess **306** shown in figure 29 by any number of  
means such as gluing or the like.

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Sealing plate **304** is used to provide a smooth surface for a substantially  
air tight seal with valve face **308** . The holes or ports **401** ,**402** , and **403** , and  
**448** match those of **501** , **502** , **503** , and **548** in valve recess **306**.

25 Figure 28 and 29 illustrates a yet further embodiment of the intermittent  
module and particularly the intermittent section **86** . Intermittent section **86**  
includes intermittent module port **101** , intermittent regulator port **102** , diaphragm  
port **103** and exhaust port **148**. An inflate timing needle valve **150** registers in  
exhaust hole **154** as previously described and opens to atmosphere to control the  
30 time that the patient has a vacuum as previously described. The deflate timing  
timing needle valve **106** is received by receiving hole **128** . The deflate timing  
needle valve **106** controls the time the patient has no vacuum. In one

embodiment the inflate timing needle valve **150** and deflate timing needle valve **106** can be adjusted for a 2:1 ratio of vacuum to vacuum off. Other ratios can be selected.

5           With reference to figure 29 , when the valve **104** is in the right most position in valve recess **306** coupler **300** covers intermittent regulator port **502** and the space to the right thereof ; which blocks or closes intermittent regulator port **502** resulting in no vacuum to the patient . At the same time coupler **301** covers intermittent module port **501** and diaphragm port **503** ; to allow the supply  
10 vacuum to evacuate the air from the diaphragm chamber through the deflate timing needle valve **106** ( which controls the timing that the patient does not receive vacuum since the vacuum is being directed to the diaphragm chamber ). Also during this time exhaust port **548** is blocked by the extra meat or land **550** on the valve **104** next to coupler **301**.

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          Once the diaphragm chamber is emptied enough of air the switching as described occurs and causes the valve **104** to rotate counter clockwise as viewed in figure 29. Now coupler **300** covers intermittent regulator port **502** and intermittent module port **501** providing vacuum from intermittent port **14** to the  
20 patient through regulator port **12**. Coupler **301** covers exhaust port **548** and diaphragm port **503** . Since the inflate timing needle valve **150** is open to atmosphere air enters there through the needle valve and into the diaphragm chamber **122** , which begins to fill with air. The cycle starts over.

25           Moreover the surface **S** shown in figure 28 includes a gasket not shown having the same general configuration as surface **S** and is adapted to be sandwiched between intermediate section **84** and cover **82** ( which will have a similar configuration to surface **S** ) to produce an air -tight seal for passages **92** , **200** , **107** , and **88**.

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          In order to improve the accuracy or precision of timing, a separate chamber **600** can be provided which communicates with the diaphragm chamber

**122** by means of channel **601** . One end of the channel **601** ports to chamber **600** while another end of channel **601** ports to diaphragm chamber **122** at port **201**. In other words the volume of diaphragm chamber **122** is increased by chamber to more accurately control the timing characteristics of the on and off cycle of the intermittent volume. The top of chamber **600** shown in fig 29 will in the assembled intermittent module include a top ( not shown )

The invention disclosed herein also describes a vacuum regulator having a channel **10** for intermittent vacuum flow, a channel **5** for regulating the level of the vacuum, and an intermittent vacuum module **80** remove securable to the vacuum regulator where the intermittent vacuum module **80** presents:

1. intermittent module port **101** for communicating with the intermittent vacuum channel **10**;
2. a module regulator port **102** for communicating with the regulator channel **5**;
3. a diaphragm assembly with a diaphragm chamber **122** having a diaphragm port **103**;
4. a valve **104** for intermittently connecting
  - (i) the intermittent module port **101** to the diaphragm port **103** so as to expose the diaphragm assembly **108** to a vacuum in the first position; and
  - (ii) the diaphragm port **103** to the exhaust port **148** to evacuate the vacuum from the diaphragm chamber **122** to ambient in a second position at the same time the intermittent module port **101** is connected to the module regulator port **102** to provide vacuum to the patient

5. a spring loaded swing arm associated with the diaphragm assembly **108** and valve **104** for intermittently displacing the valve **104** when the diaphragm assembly **108** is exposed to the vacuum in the first position and ambient pressure in the second position.

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Moreover, the vacuum regulator as shown further includes:

1. a vacuum channel **6**

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2. a full vacuum output channel **7**

3. a selector **28** having

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- (a) an intermittent selector port **42**

- (b) a full vacuum selector port **40**

- (c) a vacuum inlet selector port **26**

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- (d) a regulator selector port **44**

4. a gasket **64** for blocking the full vacuum selector port **41**

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5. a vacuum dial **28** having a valve coupler **32, 34** for

- (a) coupling the vacuum inlet selector port **27** to the regulator selector port **45** for regulating the vacuum level;

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- (b) coupling the vacuum inlet selector port **27** to the intermittent selector port **43** for intermittent vacuum; and

- (c) turning the vacuum off.

Moreover, the invention described herein illustrates the method of producing an intermittent vacuum by moving a valve **104** to the first position to couple a supply of vacuum to the diaphragm chamber **122** having a diaphragm assembly **108** move in response to the vacuum for moving a spring loaded swing arm so as to move the valve **104** to a second position to couple the supply of vacuum to a regulated port and to relieve vacuum from the diaphragm chamber **122** and move the diaphragm in response to said relief for moving the spring loaded swing arm so as to move the valve **104** to the first position.

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The ratio of the vacuum on to the off time has been selected at a ratio of 2:1. However, any ratio might be selected and the time duration of the vacuum on versus the vacuum off may be controlled by turning the needle valve 106 as described.

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Although the preferred embodiment as well as the operation in use have been specifically described in relation to the drawings, it should be understood that the variations of the preferred embodiment could be achieved by a person skilled in the trade without departing from the spirit of the invention as claimed

20 herein.